IN THE SPECIFICATION:

Page 1, line 10, after SUMMARY OF THE INVENTION, please insert the following paragraphs:

According to the present invention, an optical system has at least one deformable mirror so that focusing can be performed by only deformation of the deformable mirror.

According to the present invention, an optical apparatus uses the optical system which has at least one deformable mirror so that focusing can be performed by only deformation of the deformable mirror.

According to the present invention, in an optical system and an optical apparatus using the optical system, the optical system has at least one deformable mirror so that focusing can be performed by only deformation of the deformable mirror, and the deformable mirror is constructed so that as an object distance for focusing is reduced, positive power is increased.

According to the present invention, an optical system includes a deformable mirror and applies a shift and tilt to at least one lens or an imaging plane in order to correct decentering aberration produced by the deformable mirror. In this case, the shift takes place in a certain plane and a rotary axis of the tilt is perpendicular to the plane.

Page 1, line 11 through page 11, line 20, please delete and move all of this material and reinsert it <u>in amended form</u> at:

Page 13, line 20, after the DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS, please insert the <u>amended</u> paragraphs as follows:

The [present invention provides an] optical system <u>of the present invention</u> has at least one deformable mirror and <u>the optical system</u> is constructed so that focusing can be performed by only the deformation of the deformable mirror. According to this construction, there is no need to drive lenses in focusing, and thus an optical system and an optical apparatus that are extremely low in power consumption, noiseless in operation, simple in mechanical structure, compact in design, and low in cost, can be realized.

[According to the present invention, the] <u>The</u> deformable mirror has the advantage that it is deformed into a rotationally asymmetrical shape in a preset state in order to reduce decentering aberration. By this advantage, good imaging performance can be obtained in the whole focusing region. When the deformable mirror is deformed to have power, its reflecting surface is decentered with respect to incident light and therefore decentering aberration is

produced on reflection. In order to correct this decentering aberration, it is desirable that the deformable mirror is deformed into the rotationally asymmetrical shape.

[According to the present invention, in] In order to correct decentering aberration, at least one rotationally symmetrical lens or an imaging plane is placed so that it is decentered with respect to the Z axis. By this advantage, the deformable mirror is such that as its power is strengthened, the amount of residual decentering aberration increases. In such a case also, however, it becomes possible to obtain favorable optical performance. Also, in the present invention, decentering or decentration refers to a shift or tilt.

[According to the present invention, the] The deformable mirror is constructed so that as the object distance for focusing is reduced, its positive power is increased. By this advantage favorable optical performance can be obtained in a wide range from a far point to a near point. Also, in this specification, the signs of power are defined as plus when the mirror has a converging function and minus when it has a diverging function. That is, in the deformable mirror, as the amount of deformation of a concave surface is increased, the positive power is strengthened.

[According to the present invention, the] The deformable mirror is designed so that either the positive power or the negative power can be assumed by deformation. By this design, favorable optical performance can be secured while suppressing the production of decentering aberration in the deformable mirror. That is, in the deformable mirror, the amount of deformation increases with increasing power and thereby decentering aberration is produced to cause the deterioration of optical performance. However, the deformable mirror has either the positive power or the negative power to thereby hold the amount of deformation, and favorable optical performance can be secured while suppressing the production of decentering aberration.

[According to the present invention, the] The deformable mirror is also designed so that only the positive power can be assumed. By this design, mechanical and electrical structures are simplified, thus providing a deformable mirror of low cost.

[According to the present invention, the] The deformable mirror is constructed so that when its mirror surface is deformed, the periphery of the mirror is fixed.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have at least one cemented lens. This construction allows chromatic aberrations produced in individual lens units to be favorably corrected and is capable of contributing to a compact design of the optical system.

[According to the present invention, when] When the maximum amount of deformation of the deformable mirror is represented by md and the focal length of the optical system is

represented by fl, the optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|md/fl|<0.1 \quad (1-1)$$

Here, the focal length fl of the optical system is defined as that where the deformable mirror has a planar shape. The same holds for conditions to be described below.

By this condition, the amount of deformation of the deformable mirror can be kept within a proper limit. That is, beyond the upper limit of Condition (1-1), the amount of deformation of the deformable mirror is extremely increased and the amount of production of decentering aberration is increased. Consequently, it becomes difficult to fulfill desired optical performance. Moreover, the degree of difficulty of fabrication becomes remarkable.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|md/fl|<0.05 \quad (1-2)$$

By this condition, the amount of production of decentering aberration can be further held.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|md/fl|<0.03 \quad (1-3)$$

By this condition, the amount of production of decentering aberration can be more favorably held.

[According to the present invention, when] When the area of an optically effective reflecting surface in the deformable mirror is denoted by Sm, the optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<md^2/Sm<5.0\times10^{-4} \quad (2-1)$$

By this condition, the amount of deformation of the deformable mirror can be kept within a proper limit.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<md^2/Sm<1.0\times10^{-4} \quad (2-2)$$

By this condition, the amount of deformation of the deformable mirror can be more favorably kept within a proper limit.

[According to the present invention, the] <u>The</u> optical system including the deformable mirror is such that the deformable mirror is driven by an electrostatic driving system in focusing, and when a voltage applied to the deformable mirror in focusing is represented by Vm (volt), the optical system satisfies the following condition in a preset state:

$$0<|Vm|<500 \tag{3-1}$$

By this condition, the dangerous property of atmospheric discharge is diminished and at the same time, the amount of deformation of the deformable mirror can be increased.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system are such that the deformable mirror is driven by the electrostatic driving system when focusing is performed by the deformable mirror, and satisfies the following condition in a preset state:

$$0<|Vm|<300 \tag{3-2}$$

By this condition, power consumption can be lowered and thus the optical system and the optical apparatus that are more favorable can be provided.

[According to the present invention, when] <u>When</u> the power of the deformable mirror is denoted by ϕDM, the optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|\phi DM x fl|<1.00 \tag{4-1}$$

Here, the power ϕDM of the deformable mirror is the average value of a power ϕDMy in a plane in a decentering direction (the Y direction) of the deformable mirror and a power ϕDMx in a plane in a direction perpendicular to the Y direction (the X direction), and is defined as $\phi DM=(\phi DMx+\phi DMy)/2$.

By this condition, the focusing function of the deformable mirror can be satisfactorily performed, and decentering aberration produced in the deformable mirror can be kept within a proper limit.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|\phi DM x fl|<0.50 \tag{4-2}$$

By this condition, decentering aberration produced in the deformable mirror can be further suppressed, which is more desirable.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0<|\phi DM \times fl|<0.10 \quad (4\text{-}3)$$

By this condition, decentering aberration produced in the deformable mirror can be more favorably suppressed.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that when focusing is carried out at the far point by the deformable mirror, the deformable mirror can be deformed to have lower power than in focusing. By this advantage, an autofocus operation of the contrast system can be performed. Specifically, the deformable mirror has lower power than in focusing at the far point, and thereby the blurring of an image at the far point can be adjusted.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that when focusing is carried out at the near point by the deformable mirror, the deformable mirror can be deformed to have higher power than in focusing.

By this advantage, the autofocus operation of the contrast system can be performed. Specifically, the deformable mirror has higher power than in focusing at the near point, and thereby the blurring of an image at the near point can be adjusted.

[According to the present invention, the] The optical system and the optical apparatus using the optical system are such that when focusing is performed by the deformable mirror at the object point where the object distance is infinite, the deformable mirror is deformed not into a planar surface, but into a concave surface that has larger power than zero.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have a lens unit with negative power on the object side of the deformable mirror and satisfy the following condition:

$$-5.0<f1/fl<-0.2 \quad (5\text{-}1)$$

where f1 is the focal length of the lens unit.

By this condition, compactness, cost reduction, and favorable optical performance of the deformable mirror can be obtained. That is, below the lower limit of Condition (5-1), the power of the lens unit with negative power is extremely weakened, and the off-axis ray height of the deformable mirror at the wide-angle position cannot be decreased. This leads to oversizing of the deformable mirror and raises cost. Beyond the upper limit of Condition (5-1), the power of

the lens unit with negative power is extremely strengthened, and it becomes difficult to correct coma and chromatic aberration of magnification, produced in the lens unit.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition:

$$-2.5<f1/fl<-0.5 \qquad (5\text{-}2)$$

By this condition, favorable optical performance is ensured and at the same time, further compactness of the deformable mirror can be achieved, which is more desirable.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that the lens unit with negative power, located on the object side of the deformable mirror, is constructed with a single concave lens. By this advantage, a compact- and slim-design optical system can be achieved because only one lens is placed on the object side of the deformable mirror.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that the lens unit with negative power, located on the object side of the deformable mirror, is constructed with two lenses. By this advantage, the optical system and the optical apparatus using the optical system that excel in the ability to correct aberrations, such as distortion and chromatic aberration of magnification, can be realized.

[According to the present invention, when] When an angle where an axial chief ray is bent by the deformable mirror is denoted by θ, the optical system and the optical apparatus using the optical system satisfy the following condition:

$$60° < \theta < 120° \qquad (6\text{-}1)$$

Below the lower limit of Condition (6-1), the longitudinal dimension of the deformable mirror must be increased and a cost reduction becomes difficult. Beyond the upper limit of Condition (6-1), the size of the mirror is reduced, but lens units located in front of and behind the deformable mirror interfere with each other, and the arrangement of the optical system is rendered difficult. Also, the chief ray described here refers to a ray that emerges from the center of the object, passes through the center of a stop, and reaches the center of an image.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition:

$$75° < \theta < 105° \qquad (6\text{-}2)$$

By this condition, a better result is brought about.

[According to the present invention, when] When the magnification of a lens unit ranging from an optical surface situated immediately behind the deformable mirror to the last surface is represented by $\beta 1$, the optical system and the optical apparatus using the optical system satisfy the following condition:

$$0.35<|\beta 1|<1.50 \qquad (7\text{-}1)$$

Below the lower limit of Condition (7-1) the magnification of the lens unit located behind the deformable mirror becomes so low that a focus sensitivity of the deformable mirror is impaired and the amount of deformation of the deformable mirror required for focusing is increased. Beyond the upper limit of Condition (7-1), the magnification of the lens unit is so high that decentering aberration produced in the deformable mirror is increased and it becomes difficult to obtain satisfactory optical performance.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition:

$$0.50<|\beta 1|<1.20 \qquad (7\text{-}2)$$

By this condition, the amount of deformation of the deformable mirror can be kept within a proper limit while ensuring optical performance, and thus a better result is brought about.

[According to the present invention, when] When the overall length of the optical system is denoted by Cj, the optical system and the optical apparatus using the optical system satisfy the following condition:

$$1.0<Cj/f1<20.0 \qquad (8\text{-}1)$$

Beyond the upper limit of Condition (8-1), the overall length of the optical system is extremely increased and compactness of the optical system becomes difficult. Below the lower limit of Condition (8-1), the compactness is attained, but the arrangement of lens units is limited and satisfactory optical performance cannot be obtained.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition:

$$3.0<Cj/f1<15.0 \qquad (8\text{-}2)$$

By this condition, a compact optical system and higher optical performance can be obtained.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition:

$$5.0<Cj/f1<10.0 \qquad (8\text{-}3)$$

By this condition, a better result is brought about.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system are such that at least one lens is shifted in order to correct decentering aberration produced by the deformable mirror, and satisfy the following condition in a preset state:

$$0.0<|\delta/fl|<1.00 \qquad (9\text{-}1)$$

where δ is the amount of shift of the lens.

By this condition, the amount of decentration applied to the lens can be kept within a proper limit, and the balance of optical performance between a weak power and a strong power of the deformable mirror can be held. Here, the amount of shift δ refers to the amount defined as a distance between the center axis of the shifted lens and the Z axis of the optical system.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0.0<|\delta/fl|<0.50 \qquad (9\text{-}2)$$

By this condition, performance in focusing at the far and near points can be further improved.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0.0<|\delta/fl|<0.25 \qquad (9\text{-}3)$$

By this condition, a better result is brought about.

The optical system and the optical apparatus using the optical system are such that a lens unit with negative power, placed on the object side of the deformable mirror, is constructed with two lenses, and satisfy the following condition:

$$\delta_1 \times \delta_2 < 0 \qquad (9\text{-}4)$$

where δ_1 and δ_2 are shifts applied to the two lenses.

By this condition, that is, by reversing the directions of the shifts applied to the lens unit with negative power, a considerable effect is brought about on correction for decentering aberration produced in the deformable mirror.

[According to the present invention, the] <u>The</u> optical system and the optical apparatus using the optical system are such that at least one lens or an imaging plane is tilted in order to correct decentering aberration produced by the deformable mirror, and satisfy the following condition in a preset state:

$$0.0° < |\epsilon|<10.0° \qquad (10\text{-}1)$$

where ϵ is the amount of tilt applied to the lens or the imaging plane.

By this condition, the amount of decentration applied to the lens can be kept within a proper limit, and the balance of optical performance between a weak power and a strong power of the deformable mirror can be held. Here, the amount of tilt ϵ refers to the amount defined as a tilt angle made by the center axis of the tilted lens or imaging plane with he Z axis of the optical system.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0.0° < |\epsilon| < 7.0° \qquad (10\text{-}2)$$

By this condition, performance in focusing at the far and near points can be further improved.

[According to the present invention, the] The optical system and the optical apparatus using the optical system satisfy the following condition in a preset state:

$$0.0° < |\epsilon| < 5.5° \qquad (10\text{-}3)$$

By this condition, a better result is brought about.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that, of the absolute values of the amounts of tilt applied to individual lenses or the imaging plane, the absolute value of the amount of tilt of the imaging plane is largest.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that the direction of tilt applied to the imaging plane is a direction approaching parallel to the deformable mirror.

[According to the present invention, the] The optical system and the optical apparatus using the optical system have the advantage that, in the optical system in which the shift and tilt are applied to at least one lens or an imaging plane in order to correct decentering aberration produced by the deformable mirror, the shift takes place in a certain plane and the rotary axis of the tilt is perpendicular to the plane.

[According to the present invention, the] The optical system and the optical apparatus using the optical system are such that the stop is placed on the image side of the deformable mirror.

[According to the present invention, the] The optical system that affords a small number of moving lens units, a compact design, low power consumption, and noiseless operation, and the optical apparatus using the optical system, can be provided.

IN THE DRAWING(S):

The attached sheet of drawing includes changes to Figure 1. This sheet replaces the original sheet showing Figure 1.

Attachment: Replacement Sheet.